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Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices











IPC/JEDEC J-STD-033A

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A joint standard developed by the EIA/JEDEC JC-14.1 Committee on Reliability Test Methods for Packaged Devices and the B-10a Plastic Chip Carrier Cracking Task Group of IPC



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Users of this standard are encouraged to participate in the development of future revisions.

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Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices

1 FOREWORD

The advent of surface mount devices (SMDs) introduced a new class of quality and reliability concerns regarding package damage "cracks and delamination" from the solder reflow process. This document describes the standardized levels of floor life exposure for moisture/reflow-sensitive SMD packages along with the handling, packing and shipping requirements necessary to avoid moisture/reflow-related failures. Companion documents, J-STD-020, define the classification procedure and JEP113 define the labeling requirements.

Moisture from atmospheric humidity enters permeable packaging materials by diffusion. Assembly processes used to solder SMD packages to printed circuit boards (PCBs) expose the entire package body to temperatures higher than 200°C. During solder reflow, the combination of rapid moisture expansion, materials mismatch, and material interface degradation can result in package cracking and/or delamination of critical interfaces within the package.

The solder reflow processes of concern are convection, convection/IR, infrared (IR), vapor phase (VPR) and hot air rework tools. The use of assembly processes that immerse the component body in molten solder are not recommended for most SMD packages.

1.1 Purpose The purpose of this document is to provide SMD manufacturers and users with standardized methods for handling, packing, shipping, and use of moisture/reflow sensitive SMD packages which have been classified to the levels defined in J-STD-020. These methods are provided to avoid damage from moisture absorption and exposure to solder reflow temperatures that can result in yield and reliability degradation. By using these procedures, safe and damage-free reflow can be achieved, with the dry packing process, providing a minimum shelf life capability in sealed dry-bags of 12 months from the seal date.

1.2 Scope

1.2.1 Packages

1.2.1.1 Non-Hermetic This standard applies to all non-hermetic SMD packages subjected to bulk solder reflow processes during PCB assembly, including plastic encapsulated packages and all other packages made with moisture-permeable polymeric materials (epoxies, silicones, etc.) that are exposed to the ambient air.

1.2.1.2 Hermetic Hermetic SMD packages are not moisture sensitive and do not require moisture precautionary handling.

1.3 Assembly Processes

1.3.1 Mass Reflow This standard applies to bulk solder reflow assembly by convection, convection/IR, infrared (IR), and vapor phase (VPR), processes. It does not apply to bulk solder reflow processes that immerse the component bodies in molten solder (e.g., wave soldering bottom mounted components). Such processes are not allowed for many SMDs and are not covered by the component qualifications standards used as a basis for this document.

1.3.2 Localized Heating This standard also applies to moisture sensitive SMD packages that are removed or attached singly by local ambient heating, i.e., "hot air rework." See Clause 6.

1.3.3 Socketed Components This standard does not apply to SMD packages that are socketed and not exposed to solder reflow temperatures. Such SMD packages are not at risk and do not require moisture precautionary handling.

1.3.4 Point-to-Point Soldering This standard does not apply to SMD packages in which only the leads are heated to reflow the solder, e.g., hand-soldering, hot bar attach of gull wing leads, and through hole by wave soldering. The heat absorbed by the package body from such operations is typically much lower than for bulk surface mount reflow or hot air rework, and moisture precautionary measures are typically not needed.

1.4 Reliability The methods set forth in this specification ensure that an adequate SMD package reliability can be achieved during and after the PCB assembly operation, when the SMD packages are evaluated and verified by J-STD-020 and/or by JESD22-A113 plus environmental reliability testing.

This specification does not address or ensure solder joint reliability of attached components.

1.5 Terms and Definitions

1.5.1 Active Desiccant Desiccant that is either fresh (new) or has been baked according to the manufacturer's recommendations to renew it to original specifications.

1.5.2 Bar Code Label The manufacturer's label gives information in a code consisting of parallel bars and spaces, each of various specific widths.

NOTE: For the purpose of this standard, the bar code label is on the lowest level shipping container and includes information that describes the product, e.g., part number, quantity, lot information, supplier identification, and moisture-sensitivity level.

1.5.3 Bulk Reflow Reflow of multiple components with simultaneous attachment by an infrared (IR), convection/IR, convection, or vapor phase reflow (VPR) process.

1.5.4 Carrier A container that directly holds components such as a tray, tube, or tape and reel.

1.5.5 Desiccant An absorbent material used to maintain a low relative humidity.

1.5.6 Floor Life The allowable time period, after removal from a moisture barrier bag and before the solder reflow process, for a moisture-sensitive device to be exposed to a factory ambient not exceeding 30°C and 60% RH.

1.5.7 Humidity Indicator Card (HIC) A card on which a moisture-sensitive chemical is printed such that it will change color from blue to pink when the indicated relative humidity is exceeded. This is packed inside the moisture-sensitive bag, along with the desiccant, to aid in determining the level of moisture to which the moisture-sensitive devices have been subjected.

1.5.8 Manufacturer's Exposure Time (MET) The maximum time after bake that the component manufacturer requires to process components prior to bag seal. It also includes the maximum time allowed at the distributor for having the bag open to split out smaller shipments.

1.5.9 Moisture Barrier Bag (MBB) A bag designed to restrict the transmission of water vapor and used to pack moisture-sensitive devices.

1.5.10 Rework The removal of a component for scrap, reuse or failure analysis, attachment of a replacement component or heating and repositioning of a previously attached component.

1.5.11 Shelf Life The time that a dry-packed moisture-sensitive device may be stored in an unopened moisture barrier bag (MBB) such that the required interior bag ambient humidity is maintained.

1.5.12 Surface Mount Device (SMD) For the purpose of this standard, SMD is restricted to include only plastic-encapsulated SMDs and other packages made with moisture-permeable materials.

1.5.13 Solder Reflow A solder attachment process in which previously applied solder or solder paste is melted to attach a component to the printed circuit board.

1.5.14 Water Vapor Transmission Rate (WVTR) A measure of the permeability of plastic film or metallized plastic film material to moisture.

2 APPLICABLE DOCUMENTS

2.1 American Society for Testing and Materials (ASTM)[1]

ASTM F 1249 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

ASTM F 392 Standard Test Method for Flex Durability of Flexible Barrier Materials

2.2 Electronic Industries Alliance (EIA, JEDEC)[2]

EIA-541 Packaging Material Standards for ESD Sensitive Items

JESD-625 Requirements for Handling Electrostatic Discharge Sensitive (ESD) Devices

JEP-113 Symbol and Labels for Moisture Sensitive Devices

JESD22-A113 Preconditioning of Non-hermetic Surface Mount Components Prior to Reliability Testing

JESD22-A120 Test Method for the Measurement of Moisture Diffusivity and Water Solubility in Organic Materials Used in Integrated Circuits

2.3 IPC Standards[3]

IPC-7711 Rework of Electronic Assemblies

IPC-7721 Repair and Modification of Printed Boards and Electronic Assemblies

2.4 Joint Industry Standards[4]

J-STD-020 Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices

2.5 Department of Defense[5]

MIL-PRF-81705 Type I - Barrier Materials Flexible. Electrostatic-free. Heat Sealable

MIL-D-3464 Type II - Desiccant, Activated, Bagged, Packaging Use and Static Dehumidification

MIL-I-8835 Indicator, Humidity, Card, Chemically Impregnated

3 DRY PACKING

3.1 Requirements Dry packing requirements for the various moisture sensitivity levels are shown in Table 3-1. The levels are determined per J-STD-020 and/or per JESD22-A113 plus reliability testing. As a minimum all materials used in dry packing should conform to EIA-541.

3.2 Drying of SMD Packages and Carrier Materials Before Being Sealed in MBBs

3.2.1 Drying Requirements - Levels 2a - 5a SMD packages classified at Levels 2a through 5a must be dried (see Clause 4) prior to being sealed in MBBs. The period between drying and sealing must not exceed the MET less the time allowed for distributors to open the bags and repack parts. If the supplier's actual MET is more than the default 24 hours, then the actual time must be used. If the distributor practice is to repack the MBBs with active desiccant, then this time does not need to be subtracted from the MET.

1. www.astm.org
2. www.eia.org; www.jedec.org
3. www.ipc.org
4. www.eia.org; www.jedec.org; www.ipc.org
5. http://astimage.daps.dla.mil/quicksearch/

Table 3-1 Dry Packing Requirements

Level	Dry Before Bag	MBB	Desiccant	MSID* Label	Caution Label
1	Optional	Optional	Optional	Not Required	Not Required if classified at 220° - 225°C Required** if classified at other than 220° - 225°C
2	Optional	Required	Required	Required	Required
2a-5a	Required	Required	Required	Required	Required
6	Optional	Optional	Optional	Required	Required

*MSID = Moisture-Sensitive Identification Label
**A "Caution" label is not required if level and reflow temperature are given, in human readable form, on the barcode label attached to the lowest level shipping container.

3.2.2 Drying Requirements - Carrier Materials Carrier materials, such as trays, tubes, reels, etc., that are placed in the MBB can affect the moisture level within the MBB. Therefore, the effect of these materials must be compensated for by baking or, if required, adding additional desiccant in the MBB to ensure the shelf life of the SMD packages (see 7.2).

3.2.3 Drying Requirements - Other Suppliers may use the drying effect of normal in-line processes such as post mold cure, marking cure, and burn-in to reduce the bake time. An equivalency evaluation is recommended to ensure that high temperature processing maintains moisture weight gain to an acceptable level. The total weight gain for the SMD package at the time it is sealed in the MBB must not exceed the moisture gain of that package starting dry and then being exposed to 30°C/60% RH for MET hours (less the time for distributors).

3.2.4 Excess Time Between Bake and Bag If the allowable time between bake and bag is exceeded, the SMD packages must be redried per Clause 4.

3.3 Dry Pack

3.3.1 Description Dry pack consists of desiccant material and a Humidity Indicator Card (HIC) sealed with the SMD packages inside a Moisture Barrier Bag (MBB). A representative dry pack configuration is shown in Figure 3-1.

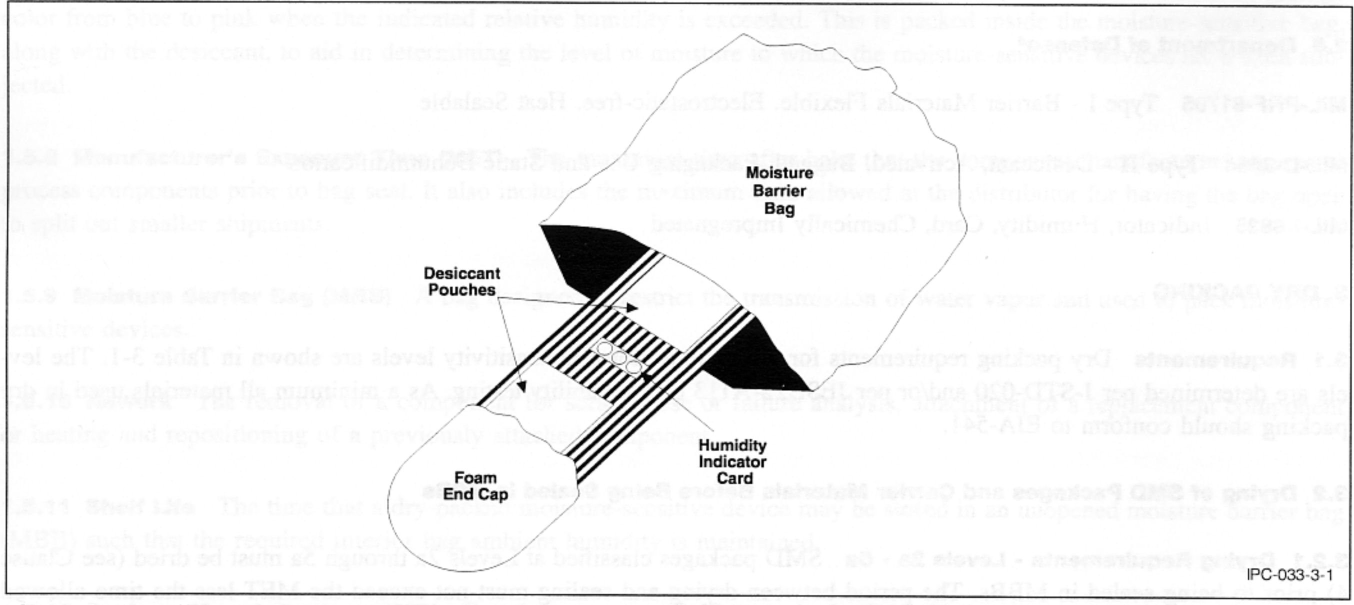


Figure 3-1 Typical Dry Pack Configuration for Moisture-Sensitive SMD Packages in Shipping Tubes

3.3.2 Materials

3.3.2.1 Moisture Barrier Bag (MBB) The moisture barrier bag **shall** meet MIL-PRF-81705, TYPE I requirements for flexibility, ESD protection, mechanical strength, and puncture resistance. The bags **shall** be heat sealable. The Water Vapor Transmission Rate (WVTR) **shall** be ≤0.002 gm/100 in^2 in 24 hrs at 40°C after flex testing per condition "E" ASTM F 392. The WVTR is measured using ASTM F 1249.

3.3.2.2 Desiccant The desiccant material **shall** meet MIL-D-3464, TYPE II. Desiccant **shall** be dustless, non-corrosive, and absorbent to amounts specified in the standard. The desiccant **shall** be packaged in moisture permeable bags or pouches. The amount of desiccant used, per moisture barrier bag, **shall** be based on the bag surface area and WVTR in order to maintain an interior relative humidity in the MBB of less than 10% at 25°C.

For comparison between various desiccant types, military specifications adopted the "UNIT" as the basic unit of measure of quantity for desiccant material. A UNIT of desiccant is defined as the amount that will absorb a minimum of 2.85 g of water vapor at 20% RH and 25°C. To meet the dry pack requirements of this standard the amount of water vapor that a UNIT of desiccant can absorb at 10% RH and 25°C must be known.

When the desiccant capacity at 10% RH and 25°C is known the following equation should be used.

$$U = (0.304 * M * WVTR * A)/D$$

where:
U = Amount of desiccant in UNITS
M = Shelf life desired in months
WVTR = Water vapor transmission rate in grams/100 in^2 in 24 hrs
A = Total surface area of the MBB in square inches
D = The amount of water in grams, that a UNIT of desiccant will absorb at 10% RH and 25°C

When the desiccant capacity at 10% RH and 25°C is not known the quantity needed can be estimated using the following simplified equation.

$$U = 5 \times 10^{-3} A$$

where:
U = Amount of desiccant in UNITS
A = Total surface area of the MBB in square inches

Note: If materials such as trays, tubes, reels, foam end caps, etc., are placed in the bag without baking, additional desiccant will be required to absorb the moisture contained in these materials.

3.3.2.3 Humidity Indicator Card (HIC) The HIC **shall** comply with MIL-I-8835. At minimum, the HIC **shall** have three (3) color dots with sensitivity values of 5% RH, 10% RH, 15% RH. An example HIC is shown in Figure 3-2.

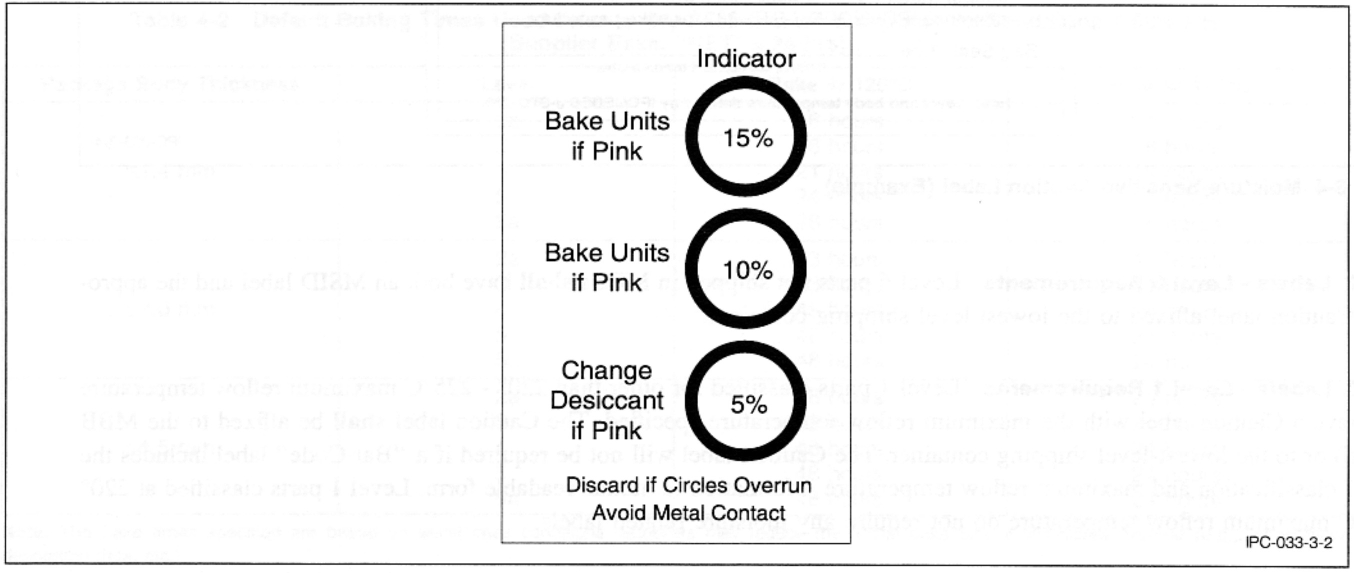


Figure 3-2 Sample Humidity Indicator Card

3.3.3 Labels

3.3.3.1 Labels - Moisture Sensitive Identification Labels relevant to the dry pack process are the "Moisture-Sensitive Identification" (MSID) label and the Caution label as specified in JEDEC JEP113 (see Figures 3-3 and 3-4). The MSID label **shall** be affixed to the lowest-level shipping container that contains the MBB. The Caution label **shall** be affixed to the outside surface of the MBB.



Figure 3-3 Moisture-Sensitive Identification Label (Example)

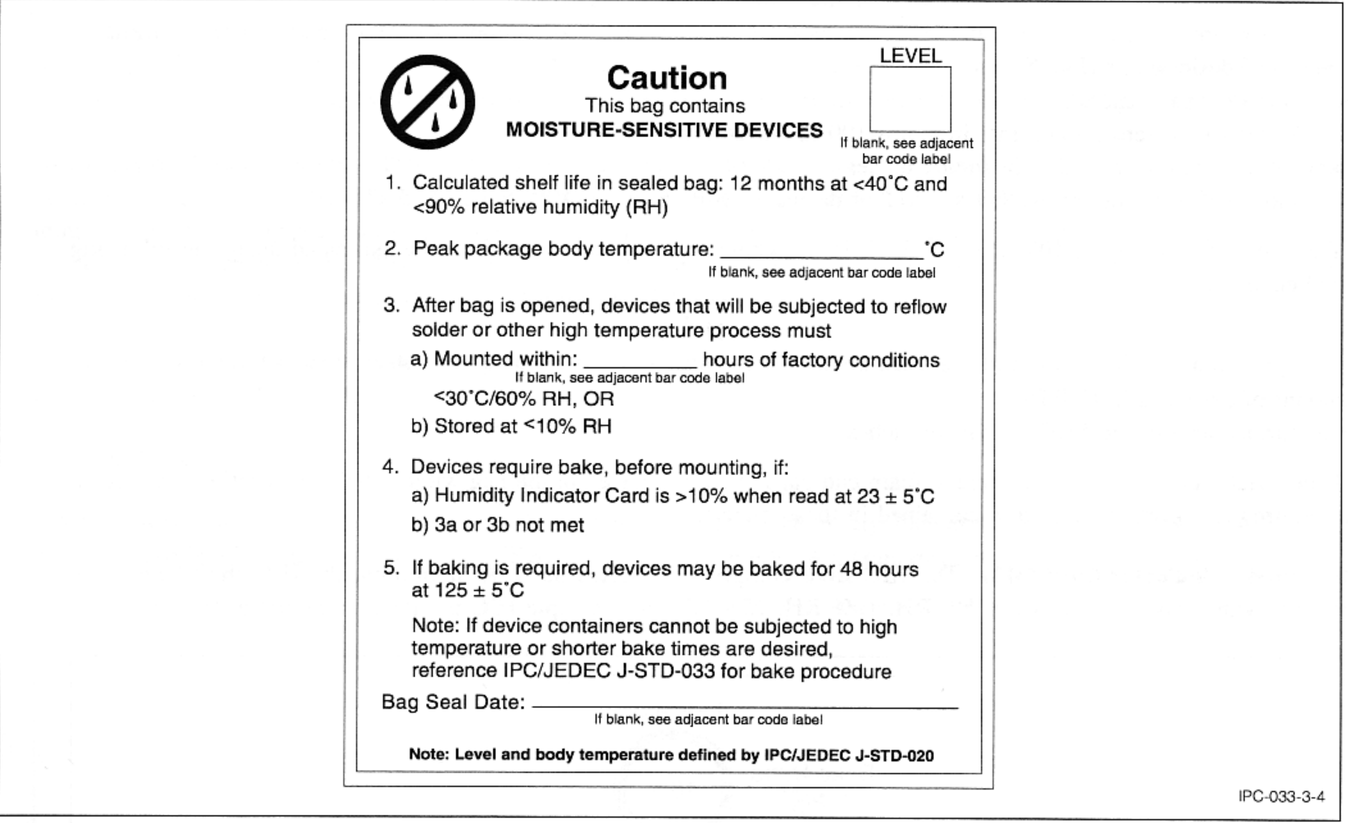


Figure 3-4 Moisture-Sensitive Caution Label (Example)

3.3.3.2 Labels - Level 6 Requirements Level 6 parts not shipped in MBBs **shall** have both an MSID label and the appropriate Caution label affixed to the lowest level shipping container.

3.3.3.3 Labels - Level 1 Requirements Level 1 parts classified for other than 220° - 225°C maximum reflow temperature **shall** have a Caution label with the maximum reflow temperature specified. The Caution label **shall** be affixed to the MBB (if used) or to the lowest-level shipping container. The Caution label will not be required if a "Bar Code" label includes the Level 1 classification and maximum reflow temperature information in human readable form. Level 1 parts classified at 220° - 225°C maximum reflow temperature do not require any moisture related labels.

3.3.4 Shelf Life The calculated shelf life for dry packed SMD packages **shall** be a minimum of 12 months from the bag seal date, when stored in a non-condensing atmospheric environment of <40°C/90% RH.

4 DRYING

Component drying options for various moisture sensitivity levels and ambient humidity exposures of ≤60% RH are given in the following two tables. Drying per an allowable option resets the floor life clock. If dried and sealed in an MBB with fresh desiccant, the shelf life is reset. Tables 4-1 and 4-2 give reference conditions for drying SMD packages. Table 4-1 gives

conditions for rebake of SMD packages at a user site after the floor life has expired or other conditions have occurred to indicate excess moisture exposure. Table 4-2 gives conditions for bake prior to dry pack at a supplier and/or distributor and allows for a maximum total of 24 hour MET. The supplier **shall** formally communicate to the distributor the maximum time that the product may be left unsealed (at the distributor) before rebaking is required.

Table 4-1 Reference Conditions for Drying Mounted or Unmounted SMD Packages (User Bake: Floor life begins counting at time = 0 after bake)

Package Body Thickness	Level	Bake @ 125°C		Bake @ 90°C ≤ 5% RH		Bake @ 40°C ≤ 5% RH	
		Saturated @ 30°C/85% RH	At Limit of Floor Life + 72 hr @ 30°C/60% RH	Saturated @ 30°C/85% RH	At Limit of Floor Life + 72 hr@ 30°C/60% RH	Saturated @ 30°C/85% RH	At Limit of Floor Life + 72 hr @ 30°C/60% RH
≤1.4 mm	2a	5 hours	3 hours	17 hours	11 hours	8 days	5 days
	3	9 hours	7 hours	33 hours	23 hours	13 days	9 days
	4	11 hours	7 hours	37 hours	23 hours	15 days	9 days
	5	12 hours	7 hours	41 hours	24 hours	17 days	10 days
	5a	16 hours	10 hours	54 hours	24 hours	22 days	10 days
≤2.0 mm	2a	21 hours	16 hours	3 days	2 days	29 days	22 days
	3	27 hours	17 hours	4 days	2 days	37 days	23 days
	4	34 hours	20 hours	5 days	3 days	47 days	28 days
	5	40 hours	25 hours	6 days	4 days	57 days	35 days
	5a	48 hours	40 hours	8 days	6 days	79 days	56 days
≤4.5 mm	2a	48 hours	48 hours	10 days	7 days	79 days	67 days
	3	48 hours	48 hours	10 days	8 days	79 days	67 days
	4	48 hours	48 hours	10 days	10 days	79 days	67 days
	5	48 hours	48 hours	10 days	10 days	79 days	67 days
	5a	48 hours	48 hours	10 days	10 days	79 days	67 days

Note: Table 4-1 is based on worst-case molded lead frame SMD packages. Users may reduce the actual bake time if technically justified (e.g.,, absorption/desorption data, etc.). In most cases it is applicable to other non-hermetic surface mount SMD packages.

Table 4-2 Default Baking Times Used Prior to Dry-Pack that were Exposed to Conditions ≤ 60% RH (Supplier Bake: "MET" = 24 hrs)

Package Body Thickness	Level	Bake @ 125°C	Bake @ 150°C
≤1.4 mm	2a	8 hours	4 hours
	3	16 hours	8 hours
	4	21 hours	10 hours
	5	24 hours	12 hours
	5a	28 hours	14 hours
≤2.0 mm	2a	23 hours	11 hours
	3	43 hours	21 hours
	4	48 hours	24 hours
	5	48 hours	24 hours
	5a	48 hours	24 hours
≤4.5 mm	2a	48 hours	24 hours
	3	48 hours	24 hours
	4	48 hours	24 hours
	5	48 hours	24 hours
	5a	48 hours	24 hours

Note: The bake times specified are based on worst case conditions. Suppliers may reduce the actual bake time if technically justified (e.g.,, absorption/desorption data, etc.).

4.1 Post Exposure to Factory Ambient Placing SMD packages, which have been exposed to factory ambient conditions for greater than one hour, in a dry cabinet or dry pack does NOT necessarily stop/pause the floor life clock. However if the conditions of 4.1.2 are met the floor life clock can be stopped or reset.

4.1.1 Any Duration Exposure Moisture sensitive SMD packages which have been exposed only to ambient conditions of ≤60% RH for any length of time may be adequately dried by high or low temperature baking according to Table 4-1 for rebake prior to reflow or Table 4-2 for drying prior to dry pack.

4.1.2 Short Duration Exposure Previously dry SMD packages, which have been exposed only to ambient conditions not exceeding 30°C/60% RH may be adequately dried by room temperature desiccation using dry pack or a dry cabinet. If dry pack is used and the total desiccant exposure is not greater than 30 minutes, the original desiccant may be reused.

4.1.2.1 Moisture Sensitivity Levels 2-4 For moisture sensitivity Levels 2-4 with floor life exposure not greater than 12 hours, a minimum desiccating period of 5X the exposure time is required to dry the SMD packages enough to **reset** the floor life clock. This can be accomplished by dry pack according to 3.3 or a dry cabinet that is capable of maintaining not greater than 10% RH.

Note: Components exposed for anytime less than their stated floor life and are moisture-sensitive Levels 2, 2a or 3, dry packing or placing the components in a dry cabinet, maintaining not greater than 10% RH, the floor life clock will **stop/ pause**, but the cumulative floor life must meet the conditions in Table 5-1 and/or Table 7-1. This does not apply to Level 4.

4.1.2.2 Moisture Sensitivity Levels 5-5a For moisture sensitivity Levels 5 and 5a with floor life exposure not greater than 8 hours, a minimum desiccating period of 10X the exposure time is required to dry the SMD packages enough to reset the floor life clock. This can be accomplished by dry pack according to 3.3 or a dry cabinet that is capable of maintaining not greater than 5% RH.

Once the floor life clock has been reset, refer to 5.3 for safe storage conditions.

4.2 General Considerations for Baking

4.2.1 High Temperature Carriers Unless otherwise indicated by the manufacturer, SMD packages shipped in high temperature carriers (e.g., high temperature trays) can be baked in the carriers at 125°C.

4.2.2 Low Temperature Carriers SMD packages shipped in low temperature carriers (e.g., tubes, low temperature trays, tape and reel) may not be baked in the carriers at any temperature higher than 40°C. If a higher bake temperature is required, SMD packages must be removed from the low temperature carriers to thermally safe carriers, baked, and returned to the low temperature carriers.

Note 1. Manual handling may increase the risk of mechanical and/or ESD damage.
Note 2. If SMD packages are placed in dry bags with unbaked carriers, refer to 3.3.2.2.

4.2.3 Paper and Plastic Container Items Paper and plastic container items such as cardboard boxes, bubble pack, plastic wrap, etc., **shall** be removed from around the carriers prior to baking. Rubber bands around tubes and plastic tray ties must also be removed prior to high temperature (125°C) bake.

4.2.4 Bakeout Times Bakeout times start when all SMD packages reach the specified temperature.

4.2.5 ESD Protection Proper ESD handling precautions should be observed, per EIA 625. This is particularly critical if SMD packages are manually handled by vacuum pencils under low humidity conditions, e.g., in a dry environment, after baking, etc.

4.2.6 Reuse of Carriers The appropriate materials specification should be consulted before reusing carriers.

4.2.7 Solderability Limitations

4.2.7.1 Oxidation Risk Baking SMD packages may cause oxidation and/or intermetallic growth of the terminations, which if excessive can result in solderability problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solderability considerations. Unless otherwise indicated by the supplier, the cumulative bake time at a temperature greater than 90°C and up to 125°C **shall not** exceed 48 hours. If the bake temperature is not greater than 90°C, there is no limit on bake time. Bake temperatures higher than 125°C are not allowed without consulting the supplier.

4.2.7.2 Carrier Out-gassing Risk Care should be taken to ensure that out-gassing of materials from the component carriers does not occur to any significant extent, such that solderability might be affected.

5 USE

Upon opening the MBB, the floor life clock starts. If an MBB is opened and the SMD packages will not be used within the specified floor life, the procedures in Clause 4 should be followed.

5.1 Incoming Bag Inspection

5.1.1 Upon Receipt Dry packed SMD packages should be inspected for a bag seal date located on the caution or bar code label. The bags should be inspected to verify there are no holes, gouges, tears, punctures or openings of any kind that would expose either the contents or an inner layer of a multilayer bag. If openings are found, and the humidity indicator card (HIC) indicates maximum humidity has been exceeded, then the parts should be baked for 48 hours at 125°C or using the saturated bake times of Table 4-1.

5.1.2 Component Inspection Intact bags may be opened for component inspection by cutting at the top of the bag near the seal. If the bags are opened under factory ambient conditions, see 4.1.2.

5.2 Floor Life The floor life of SMDs per Table 5-1 will be modified by environmental conditions other than 30°C/60% RH. Refer to Clause 7 to determine maximum allowable time before rebake would be necessary. If partial lots are used, the remaining SMD packages must be resealed or placed in safe storage within one hour of bag opening (see 5.3). If one-hour exposure is exceeded, refer to 4.1.

Table 5-1 Moisture Classification Level and Floor Life

Level	Floor Life (out of bag) at Factory Ambient ≤30°C/60% RH or as Stated
1	Unlimited at ≤30°C/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Mandatory bake before use. After bake, must be reflowed within the time limit specified on the label.

5.3 Safe Storage 'Safe storage' means dry SMD packages held in a controlled humidity condition such that the floor life clock remains at zero. Acceptable safe storage conditions for SMD packages classified as Level 2 through 5a are listed below.

5.3.1 Dry Pack Dry packed SMD packages in intact MBBs, stored per 3.3, **shall** have a calculated shelf life of at least 12 months from the bag seal date shown on the caution or bar code label.

5.3.2 Dry Atmosphere Cabinet Storage cabinets which maintain low humidity by purging with dry air or nitrogen at 25 ± 5°C. The cabinets must be capable of recovering to their stated humidity rating within one hour from routine excursions such as door opening/closing.

5.3.2.1 Dry Cabinet at 10% RH SMD packages not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 10% RH. These dry cabinets should not be considered a MBB. Storage of SMD packages in these dry cabinets should be limited to a maximum time per Table 7-1. If the time limit is exceeded they should be baked according to Table 4-2 to restore the floor life.

5.3.2.2 Dry Cabinet at 5% RH SMD packages not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 5% RH. Storage in these dry cabinets may be considered equivalent to storage in a MBB with unlimited shelf life.

5.4 Reflow Reflow includes single and multi-pass assembly reflow and single component attach/removal for rework.

5.4.1 Opened MBB After a dry pack (MBB) has been opened, all SMD packages within that bag must complete all solder reflow processing, including rework, prior to the stated floor life, resealed in the MBB, or stored in a dry atmosphere cabinet per 4.1. If the floor life or factory ambient conditions are exceeded, refer to 5.5.2.

5.4.2 Reflow Temperature Extremes During reflow the component body temperature must not exceed the rated value, stated on the Caution label. The body temperature during reflow directly influences component reliability.

Note 1. The component body temperature may be very different from the lead or solder ball temperature, particularly in IR and IR/convection processes, and should be checked separately.

Note 2. Some hot air attach processes may require heating the component body to temperatures hotter than 225°C. If that temperature exceeds the classification temperature, moisture precautions and/or time-temperature limitations beyond the scope of this specification may be required. The supplier should be consulted.

5.4.3 Additional Thermal Profile Parameters During reflow, the additional thermal profile parameters stated in JESD22-A113 should not be exceeded. Although the body temperature during reflow is the most critical parameter, other profile parameters such as the total exposure time to hot temperatures, and the heating rates, may also influence component reliability.

5.4.4 Multiple Reflow Passes If more than one reflow pass is used, care must be taken to ensure that no moisture sensitive SMD packages, mounted or unmounted, have exceeded their floor life prior to the final pass. If any component on the board has exceeded its floor life the board needs to be baked prior to the next reflow. Clause 6 should be referenced for the baking of populated boards.

Note: The floor life clock is NOT reset by any reflow or rework process.

For cavity packages in which water may be entrapped, water clean processes after the first reflow can be an additional source of moisture. This may present an additional risk, which should be evaluated.

5.4.5 Maximum Reflow Passes A maximum of three reflow passes is allowed per component. If more than three are required for any reason, the supplier must be consulted (reference J-STD-020).

5.5 Drying Indicators Events and conditions, that requires component drying prior to reflow or continued safe storage.

5.5.1 Excess Humidity in the Dry Pack Excess humidity in the dry pack is noted by the humidity indicator card (HIC). It can occur due to misprocessing (e.g., missing or inadequate desiccant), mishandling (e.g., tears or rips in the MBB), or improper storage.

The HIC should be read immediately upon removal from the MBB. For best accuracy, the HIC should be read at 23 ± 5°C. The following conditions apply regardless of the storage time, i.e., whether or not the shelf life has been exceeded.

5.5.1.1 HIC Indication 1 If the 10% RH dot is blue, the parts are still adequately dry. The desiccant **shall** be replaced by active desiccant if the bag is going to be resealed.

5.5.1.2 HIC Indication 2 If the 5% RH dot is pink and the 10% RH dot is not blue, the SMD packages have been exposed to an excessive level of moisture, and drying must be done per Clause 4.

5.5.2 Floor Life or Ambient Temperature/Humidity Exceeded If the floor life or ambient temperature/humidity conditions per Table 5-1 have been exceeded, SMD packages must be dried per Clause 4 prior to reflow or safe storage.

If the factory ambient temperature and/or humidity conditions per Table 5-1 cannot be met, the component floor life must be derated to compensate. Floor life derating is discussed in Clause 7.

5.5.3 Level 6 SMD Packages SMD packages classified as Level 6 must be dried by baking, then reflowed within the time limit specified on the label.

6 BOARD REWORK

6.1 Component Removal, Rework and Remount If a component is to be removed from the board, it is recommended that localized heating be used and the maximum body temperatures of any surface mount component on the board not exceed 200°C. This method will minimize moisture related component damage. If any component temperature exceeds 200°C, the board must be baked dry per 6.2 prior to rework and/or component removal. Component temperatures **shall** be measured at

the top center of the package body. Any SMD packages that have not exceeded their floor life can be exposed to a maximum body temperature as high as their specified maximum reflow temperature.

6.1.1 Removal for Failure Analysis Not following the requirements of 6.1 may cause moisture/reflow damage that could hinder or completely prevent the determination of the original failure mechanism.

6.1.2 Removal and Remount Removal and reinstallation or replacement of a component should be conducted following IPC-7711 or IPC-7721. If a component is to be removed and reinstalled it may be necessary to first bake the printed wiring assembly to eliminate moisture from the component. The guidelines of Table 4-1 may be used in identifying an appropriate bake cycle. When identifying a bake cycle the maximum exposure temperature and maximum rate of temperature change of components and materials on the subject printed wiring assembly must be considered and an appropriate time-temperature profile (see IPC-7711) used. Replacement SMD packages **shall not** have exceeded their specified floor life. Localized replacement reflow heating is recommended, so that the entire board is not re-subjected to reflow temperature profiles.

Note: Temperatures on neighboring SMD packages above the melting point of the solder being used may cause some solder joints to partially reflow, which may result in a potential solder joint reliability concern.

6.2 Baking of Populated Boards Some SMD packages and board materials are not able to withstand long duration bakes at ≥125°C. Examples of this are some FR-4 materials, which cannot withstand a 24 hr bake at 125°C, and some organic LEDs that have maximum temperatures of around 70°C. Batteries and electrolytic capacitors are also temperature sensitive. With component and board temperature restrictions in mind, choose a bake temperature from Table 4-1; then determine the appropriate bake duration based on the component to be removed. For additional considerations see IPC-7711 and IPC-7721.

7 DERATING DUE TO FACTORY ENVIRONMENTAL CONDITIONS

Factory floor life exposures for SMD packages removed from the dry bags will be a function of the ambient environmental conditions. A safe, yet conservative, handling approach is to expose the SMD packages only up to the maximum time limits for each moisture sensitivity level as shown in Table 5-1. This approach, however, does not work if the factory humidity or temperature are greater than the testing conditions of 30°C/60% RH. A solution for addressing this problem is to derate the exposure times based on the knowledge of moisture diffusion in the component packaging materials (ref. JESD22-A120). Recommended equivalent total floor life exposures can be estimated for a range of humidity's and temperatures based on the nominal plastic thickness for each device. Table 7-1 lists equivalent derated floor lives for humidity's ranging from 20-90% RH for three temperatures, 20°C, 25°C, and 30°C. This table is applicable to SMDs molded with novolac, biphenyl or multifunctional epoxy mold compounds. The following assumptions were used in calculating Table 7-1:

1. Activation Energy for diffusion = 0.35eV (smallest known value).
2. For ≤60% RH, use Diffusivity = 0.121exp (- 0.35eV/kT) mm^2/s (this uses smallest known Diffusivity @ 30°C).
3. For >60% RH, use Diffusivity = 1.320exp (- 0.35eV/kT) mm^2/s (this uses largest known Diffusivity @ 30°C).

Table 7-1 Recommended Equivalent Total Floor Life (days) @ 20°C, 25°C & 30°C For ICs with Novolac, Biphenyl and Multifunctional Epoxies (Reflow at same temperature at which the component was classified)

		Maximum Percent Relative Humidity										
Package Type and Body Thickness	Moisture Sensitivity Level	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	
Body Thickness ≥3.1 mm including PQFPs >84 pins, PLCCs (square) All MQFPs or All BGAs ≥1 mm	Level 2a	∞	∞	∞	60	41	33	28	10	7	6	30°C
		∞	∞	∞	78	53	42	36	14	10	8	25°C
		∞	∞	∞	103	69	57	47	19	13	10	20°C
	Level 3	∞	∞	10	9	8	7	7	5	4	4	30°C
		∞	∞	13	11	10	9	9	7	6	5	25°C
		∞	∞	17	14	13	12	12	10	8	7	20°C
	Level 4	∞	5	4	4	4	3	3	3	2	2	30°C
		∞	6	5	5	5	5	4	3	3	3	25°C
		∞	8	7	7	7	7	6	5	4	4	20°C
	Level 5	∞	4	3	3	2	2	2	2	1	1	30°C
		∞	5	5	4	4	3	3	2	2	2	25°C
		∞	7	7	6	5	5	4	3	3	3	20°C
	Level 5a	∞	2	1	1	1	1	1	1	1	1	30°C
		∞	3	2	2	2	2	2	1	1	1	25°C
		∞	5	4	3	3	3	2	2	2	2	20°C
Body 2.1 mm ≤ Thickness <3.1 mm including PLCCs (rectangular) 18-32 pins SOICs (wide body) SOICs ≥20 pins, PQFPs ≤80 pins	Level 2a	∞	∞	∞	∞	86	39	28	4	3	2	30°C
		∞	∞	∞	∞	148	51	37	6	4	3	25°C
		∞	∞	∞	∞	∞	69	49	8	5	4	20°C
	Level 3	∞	∞	19	12	9	8	7	3	2	2	30°C
		∞	∞	25	15	12	10	9	5	3	3	25°C
		∞	∞	32	19	15	13	12	7	5	4	20°C
	Level 4	∞	7	5	4	4	3	3	2	2	1	30°C
		∞	9	7	5	5	4	4	3	2	2	25°C
		∞	11	9	7	6	6	5	4	3	3	20°C
	Level 5	∞	4	3	3	2	2	2	1	1	1	30°C
		∞	5	4	3	3	3	3	2	1	1	25°C
		∞	6	5	5	4	4	4	3	3	2	20°C
	Level 5a	∞	2	1	1	1	1	1	1	0.5	0.5	30°C
		∞	2	2	2	2	2	2	1	1	1	25°C
		∞	3	2	2	2	2	2	2	2	1	20°C
Body Thickness <2.1 mm including SOICs <18 pins All TQFPs, TSOPs or all BGAs <1 mm body thickness	Level 2a	∞	∞	∞	∞	∞	∞	28	1	1	1	30°C
		∞	∞	∞	∞	∞	∞	∞	2	1	1	25°C
		∞	∞	∞	∞	∞	∞	∞	2	2	1	20°C
	Level 3	∞	∞	∞	∞	∞	11	7	1	1	1	30°C
		∞	∞	∞	∞	∞	14	10	2	1	1	25°C
		∞	∞	∞	∞	∞	20	13	2	2	1	20°C
	Level 4	∞	∞	∞	9	5	4	3	1	1	1	30°C
		∞	∞	∞	12	7	5	4	2	1	1	25°C
		∞	∞	∞	17	9	7	6	2	2	1	20°C
	Level 5	∞	∞	13	5	3	2	2	1	1	1	30°C
		∞	∞	18	6	4	3	3	2	1	1	25°C
		∞	∞	26	8	6	5	4	2	2	1	20°C
	Level 5a	∞	10	3	2	1	1	1	1	1	0.5	30°C
		∞	13	5	3	2	2	2	1	1	1	25°C
		∞	18	6	4	3	2	2	2	2	1	20°C

∞ Represents indefinite exposure time allowed at conditions specified.

Table of Contents

Figures

Tables



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